CLAIMS

Having described our invention, we claim:

1. In a scanner for determining a range to a target object which lies between a minimum range and a maximum range, wherein said scanner includes a rotatable scanning mirror capable of assuming a neutral position, a maximum positive angular displacement from said neutral position, a maximum negative angular displacement from said neutral position, and a plurality of other positions therebetween, and wherein said scanning mirror provides a plurality of scanning mirror data values corresponding to said angular displacement of said scanning mirror, a laser beam directed toward said scanning mirror and from thence out toward said target object in order to form an impact point on said target object, and a camera directed toward said scanning mirror so that a field of view of said camera is directed out toward said target object, so that said laser beam and said field of view of said camera are swept across said target object in synchronization, and wherein said camera provides a plurality of camera data values corresponding to a plurality of locations of said impact point within said field of view of said camera, with one camera data value corresponding to each particular location of said impact point within said field of view of said camera, a method for converting each of said camera data values to a distance from said scanner to said target object, comprising:

   a. providing a polynomial equation which accurately solves for said distance from said scanner to said target object when said scanning mirror is in said neutral position;

b. providing an error correction matrix, including

i. a plurality of calibrated angular positions for said rotatable scanning mirror in the range between said minimum and maximum angular displacements, inclusive of said minimum and maximum angular displacements;

ii. a plurality of calibrated linear positions for said scanner in the range between said minimum range and said maximum range;

iii. for each of said plurality of calibrated angular positions and said calibrated linear positions, an error correction value;

c. entering a specific camera data value into said polynomial and solving said polynomial in order to determine an initial calculated distance from said scanner to said target;

d. comparing said initial calculated value against said error correction matrix, using the nearest of said calibrated linear positions in said matrix to said initial calculated distance and the nearest of said calibrated angular positions in said matrix to said angular displacement of said scanning mirror, in order to determine an appropriate error correction value; and

e. adding said appropriate error correction value to said initial calculated distance in order to determine a corrected calculated distance.

2. A method as recited in claim 1, wherein interpolation is used in applying said error correction matrix.

3. A method as recited in claim 1, wherein said polynomial equation is a third order polynomial equation.

4. A method as recited in claim 1, wherein said polynomial equation is a fourth order polynomial equation.

5. A method as recited in claim 2, wherein said interpolation is linear interpolation.

6. In a scanner for determining a range to a target object which lies between a minimum range and a maximum range, wherein said scanner includes a rotatable scanning mirror capable of assuming a neutral position, a maximum positive angular displacement from said neutral position, a maximum negative angular displacement from said neutral position, and a plurality of other positions therebetween, and wherein said scanning mirror provides a plurality of scanning mirror data values corresponding to said angular displacement of said scanning mirror, a laser beam directed toward said scanning mirror and from thence out toward said target object in order to form an impact point on said target object, and a camera directed toward said scanning mirror so that a field of view of said camera is directed out toward said target object, so that said laser beam and said field of view of said camera are swept across said target object in synchronization, and wherein said camera provides a plurality of camera data values corresponding to a plurality of locations of said impact point within said field of view of said camera, with one camera data value corresponding to each particular location of said impact point within said field of view of

said camera, a method for converting each of said camera data values to a distance from said scanner to said target object, comprising:

a. selecting a plurality of calibrated angular positions for said rotatable scanning mirror in the range between said minimum and maximum angular displacements, inclusive of said minimum and maximum angular displacements;

b. for each of said plurality of calibrated angular positions providing a polynomial equation which accurately solves for said distance from said scanner to said target object; and

c. entering a specific camera data value into one of said polynomials, wherein said one of said polynomials corresponds to the calibrated angular position which is nearest to said angular displacement of said scanning mirror in order to determine a distance from said scanner to said target.

7. A method as recited in claim 6, wherein said polynomial equations are third order polynomial equations.

8. A method as recited in claim 6, wherein said polynomial equations are fourth order polynomial equations.

9. In a scanner for determining a range to a target object which lies between a minimum range and a maximum range, wherein said scanner includes a rotatable scanning mirror capable of assuming a neutral position, a maximum positive angular displacement from said neutral position, a maximum negative angular displacement from said neutral position, and a plurality of other positions therebetween, and wherein said scanning mirror provides a plurality of scanning mirror data values corresponding to said angular displacement of said scanning mirror, a laser beam directed toward said scanning mirror and from thence out toward said target object in order to form an impact point on said target object, and a camera directed toward said scanning mirror so that a field of view of said camera is directed out toward said target object, so that said laser beam and said field of view of said camera are swept across said target object in synchronization, and wherein said camera provides a plurality of camera data values corresponding to a plurality of locations of said impact point within said field of view of said camera, with one camera data value corresponding to each particular location of said impact point within said field of view of said camera, a method for converting each of said camera data values to a distance from said scanner to said target object, comprising:

a. selecting a plurality of calibrated angular positions for said rotatable scanning mirror in the range between said minimum and maximum angular displacements, inclusive of said minimum and maximum angular displacements;

b. for each of said plurality of calibrated angular positions providing a polynomial equation which accurately solves for said distance from said scanner to said target object;

c. entering a specific camera data value into a first one of said polynomials, wherein said first one of said polynomials corresponds to the calibrated angular position which is proximate to but less than said angular displacement of said scanning mirror in order to determine a first calculated distance from said scanner to said target;

d. entering a specific camera data value into a second one of said polynomials, wherein said second one of said polynomials corresponds to the calibrated angular position which is proximate to but greater than said angular displacement of said scanning mirror in order to determine a second calculated distance from said scanner to said target; and

e. interpolating between said first and second calculated distances to obtain an interpolated calculated distance.

10. A method as recited in claim 9, wherein said polynomials are third order polynomials

11. A method as recited in claim 10, wherein said polynomials are fourth order polynomials.

12. In a scanner for determining a range to a target object which lies between a minimum range and a maximum range, wherein said scanner includes a rotatable scanning mirror capable of assuming a neutral position, a maximum positive angular displacement from said neutral position, a maximum negative angular displacement from said neutral position, and a plurality of other positions therebetween, and wherein said scanning mirror provides a plurality of scanning mirror data values corresponding to said angular displacement of said scanning mirror, a laser beam directed toward said scanning mirror and from thence out toward said target object in order to form an impact point on said target object, and a camera directed toward said scanning mirror so that a field of view of said camera is directed out toward said target object, so that said laser beam and said field of view of said camera are swept across said target object in synchronization, and wherein said camera provides a plurality of camera data values corresponding to a plurality of locations of said impact point within said field of view of said camera, with one camera data value corresponding to each particular location of said impact point within said field of view of said camera, a method for calibrating said scanner, comprising:

a. determining a polynomial equation which accurately solves for a distance from said scanner to said target object when said scanning mirror is in said neutral position by

i. providing a target surface at a known distance from said scanner;

ii. correlating said known distance against a camera data value corresponding to said known distance;

iii. moving said target surface through a series of such known distances and

collecting a camera data value corresponding to each of said known distances in order to create a correlation between said camera data values and said known distances;

iv. fitting said polynomial through said correlation between said camera data values and said known distances;

b. determining an error correction matrix, including

i. a plurality of calibrated angular positions for said rotatable scanning mirror in the range between said minimum and maximum angular displacements, inclusive of said minimum and maximum angular displacements;

ii. a plurality of calibrated linear positions for said scanner in the range between said minimum range and said maximum range;

iii. for each of said plurality of calibrated angular positions and said calibrated linear positions, an error correction value;

c. wherein said polynomial can then be used to solve for an initial calculated distance for a specific camera data value;

d. wherein an appropriate error correction value can be selected using the nearest of said calibrated linear positions in said matrix to said initial calculated distance and the nearest of said calibrated angular positions in said matrix to said angular displacement of said scanning mirror, in order to determine an appropriate error correction value; and

e. wherein said appropriate error correction value can be added to said initial calculated distance in order to determine a corrected calculated distance.

13. A method as recited in claim 12, wherein interpolation is used in applying said error correction matrix.

14. A method as recited in claim 12, wherein said polynomial equation is a third order polynomial equation.

15. A method as recited in claim 12, wherein said polynomial equation is a fourth order polynomial equation.

16. A method as recited in claim 13, wherein said interpolation is linear interpolation.